Eyeglass Frame with Integrated Acoustical Communication System for Communication with a Mobile Radio Device and Corresponding Method

This invention relates to a method and a system for acoustical communication in which an eyeglass frame comprises at least one directionally dependent microphone for capturing voice signals of a user, as well as communication means for signal transmission to external electronic devices. In particular it relates to a communication system in which the directional dependence of the at least one microphone is user-specifically adjustable in a dynamic way.

Mobile communication terminals play today an increasingly important role. The newer mobile communication terminals nowadays serve not only simple voice or data communication, but they transform themselves more and more into complex multimedia devices by means of which audio or video broadcasts can be received, for example, games can be played, or information can be accessed within networks such as the Internet or mobile radio networks. The control of these complex mobile communication terminals, in particular selection of available data and/or data sets or the operational modes, as well as entry of data and/or entry of commands often proves to be involved, and often entails use of expensive and unmanageable auxiliary devices such as keyboards, styluses, trackballs, touch screens, etc. In this connection it is also essential in each instance to hold the mobile communication device in one's hand, severely restraining hands-free and convenient use of modern communication terminals.

Thus solutions based on speech recognition are already known in the state of the art. Speech recognition or automatic speech recognition deals with the study and development of methods allowing machines such as computers to recognize spoken language or respectively to convert it into character strings and process it. In the meantime speech recognition has also found technical applications in automatic dialog systems, for instance, such as e.g. a timetable enquiry. Automatic speech recognition is being practiced everywhere where only a limited vocabulary is used. With automated speech recognition, however,

the quality of the acoustical reception plays a decisive role, and therefore it is essential for the reception quality to be improved as far as possible so that a significantly higher precision in recognition can be achieved.

The publications WO 03/062906 and WO 02/086599 describe, for example, a device in which microphones and miniature loudspeakers are disposed on an eyeglass frame. The eyeglass frame is then connected to an external electronic device via a cable connection. The problem with this proposed device, however, is the difficulty in achieving an acceptable noise elimination for user-specific sound and audio recordings, and in particular in distinguishing spoken commands of a user from voices of other persons located in the vicinity.

Described in the publication EP 0 219 026 B1 is how a hearing aid can be built into an eyeglass frame. Through a particular spatial distribution of several microphones on the eyeglass frame, a directional as well as a locating effect may be achieved which should enable the hearing-impaired person to obtain a spatial orientation in relation to an acoustic event. All acoustical and electronic components are accommodated in the eyeglasses. A transmitting and/or receiving connection to external electronic devices is not provided for.

Disclosed in the published application US 2002/0197961 A1 is an eyeglass frame in which are installed microphones, miniature loudspeakers, power supply (accumulator) and transmitter or respectively receiver for the transmission of signals to a mobile radio device or other external electronic devices. Alternatively, the said components may also be accommodated in a clip which can be attached to the eyeglass frame and removed again, or on a hat or similar article worn on the head. The microphones can also be put on an adjustable arm. With use of the last-mentioned configuration in an environment with loud and non-constant static noise it is nevertheless not ensured that the wanted signal is applied at the microphone at a sufficient level.

The international application WO 2004/016037 describes a method

for improving speech intelligibility and a corresponding device. It involves an eyeglass frame containing a microphone array, a loudspeaker and a signal processing device. This signal processing device receives the signals of the microphone array, reduces the quantity of interfering background signals and transmits the thus processed signasl to the loudspeaker or an external electronic device. The eyeglass frame can also comprise a microphone control, which is able to adjust the direction of the microphone such that a better signal quality may be achieved. Various methods and algorithms can be used for signal processing, in particular the so-called ANC (Active Noise Control) technology. The beam-forming method described is nevertheless not suitable for eliminating the surrounding noises and ambient interference in every situation in an efficient way.

It is an object of this invention to propose a new system and a new method for acoustical communication not having the above-mentioned problems of the state of the art. In particular the system should make possible a convenient, hands-free use of mobile radio devices, as well as reliable and convenient entry of spoken commands and interactive speech control in connection with IVR systems (Interactive Voice Response) in noisy environments.

These objects are achieved according to the invention in particular through the elements of the independent claims. Further advantageous embodiments follow moreover from the dependent claims and from the specification.

In particular these objects are achieved through the invention in that an eyeglass frame comprises at least one directionally dependent microphone for capturing voice signals of a user as well as communication means for signal transmission to external electronic devices, and the directional dependence of the at least one microphone being user-specifically adaptable in a dynamic way by means of a control module, the control module comprising emans for adaptive user-specific adjustment of the directional dependence of the at least one

first directionally dependent microphone based on the voice signals captured by at least one second directionally dependent microphone. The advantages of this embodiment variant are, among others, that an effective noise elimination and thereby a significantly higher quality of the captured voice signals is possible for each individual user. This can be a necessary prerequisite particularly for recognition of spoken commands of the user. Further advantages are the hands-free entry of spoken instructions as well as the fact that the input device is barely visible because it is integrated into the eyeglass frame. Moreover this embodiment variant has the advantage, among others, that the adjustment of the directional dependence of the directionally dependent microphones can be carried out as a function of the signals captured by the other microphones. A still better user-specific adaptation can thereby be achieved, resulting in enhanced voice quality and better pre-requisites for application of the system and method according to the invention in environments with high levels of interfering noises.

In a further embodiment variant, at least one second directionally dependent microphone is a contact microphone. This embodiment variant has the advantage, among others, that the voice signals transmitted by the speaking user can be captured not only after propagation in the air, but also after propagation in the body of the user. After a corresponding handling and processing, a further improvement in the elimination of noise can thereby be achieved. In particular, it can very easily be determined by means of a contact microphone whether the user is speaking just now or not, whereby a possible confusion with a further user speaking in the vicinity can be practically eliminated. Moreover the signals captured by a contact microphone are very well suited to be used by the control module for adaptive user-specific adjustment of the directional dependence of the other directionally dependent microphones. In still another embodiment variant, the signal captured by a first directionally dependent microphone is filtered by means of the signal captured by a third microphone. This embodiment variant has the advantage, among others, that the ambient

noises captured by another microphone can be used for filtering and signal quality enhancement of the signals captured by the first directionally dependent microphone. The positive features of the directionally dependent microphone are thereby combined in an optimal way with the positive features of a noise elimination through filtering, leading to still better voice quality.

In a further embodiment variant, the at least one directionally dependent microphone is implemented as a microphone array. The at least one microphone array can be advantageously implemented in MEMS technology, for instance. This embodiment variant has the advantage, among others, that an especially effective and intensive directional effect can thereby be achieved. Through the use of microphone groups, many spatial features of the sound waves can also be exploited, which could not be made use of with a simple microphone. Further advantages of this embodiment variant are the much lower production costs and the high integration rate, whereby an especially small and compact construction can be achieved.

In another embodiment variant, the external device comprises a mobile radio device. The mobile radio device can thereby be integrated into an eyeglass frame, for example, or exist as a self-contained device. This embodiment variant has the advantage, among others, that the system according to the invention and the method according to the invention can be used for voice communication over a mobile radio network. Thus the wearers of the eyeglasses can also communicate via the eyeglass frame with one or more servers

Claims

1. A system for acoustical communication in which an eyeglass frame (10) comprises at least one directionally dependent microphone (13, 15, 16) for capturing voice signals of a user (21) as well as communication means (12) for signal transmission to external electronic devices (30), and in which the the directional dependence of the at least one microphone (13, 15, 16) is user-specifically adjustable in a dynamic way by means of a control module (11), wherein

the control module (11) comprises means for adaptive user-specific adjustment of the directional dependence of the at least one first directionally dependent microphone (13, 16) based on the voice signals captured by the at least one second directionally dependent microphone (13, 15).

2. The system for acoustical communication according to claim 1, wherein the at least one second directionally dependent microphone (15) is a contact microphone.

3. The system for acoustical communication according to claim 1, wherein the signal captured by a first directionally dependent microphone (16) is able to be filtered by means of the signal captured by a third microphone (13).

4. The system for acoustical communication according to one of the claims 1 to 3, wherein an amplifier (48) is controllable by means of the signal captured by a third microphone (15).

5. The system for acoustical communication according to one of the claims 1 to 4, wherein the signal captured by a directionally dependent microphone (15) is processable based on reference filters.

6. The system for acoustical communication according to one of the

claims 1 to 5, wherein the at least one directionally dependent microphone (13, 15, 16) is implemented as a microphone array.

7. The system for acoustical communication according to claim 6, wherein the at least one microphone array is implemented in MEMS technology.

8. The system for acoustical communication according to one of the claims 1 to 7, wherein the external device (30) comprises a mobile radio device.

9. The system for acoustical communication according to one of the claims 1 to 8, wherein the eyeglass frame (10) comprises means for retinal scanning display.

10. The system for acoustical communication according to claim 9, wherein the eyeglass frame (10) comprises means for capturing the direction of view.

11. The system for acoustical communication according to one of the claims 1 to 10, wherein the system comprises a speech recognition module for capturing spoken commands by means of the at least one directionally dependent microphone (13, 15, 16).

12. The system for acoustical communication according to one of the claims 1 to 11, wherein the communication system comprises Bluetooth and/or ZigBee and/or GSM and/or UMTS interfaces (12, 33).

13. The system for acoustical communication according to one of the claims 1 to 12, wherein the system comprises photovoltaic cells for the power supply (14).

14. A method for acoustical communication, in which voice signals of

a user (21) are captured by at least one directionally dependent microphone (13, 15, 16) installed on an eyeglass frame (10) and are transmitted via a wireless interface (17) to an external device (30), the directional dependence of the at least one directionally dependent microphone (13, 15, 16) being user-specifically adapted in a dynamic way, wherein

voice signals of a user are captured by means of at least one first directionally dependent microphone (13, 15), and

based on the voice signals, captured by at least one first directionally dependent microphone (13, 15), of a user (21), the directional dependence of the at least one second directionally dependent microphone (13, 16) is adaptively adjusted user-specifically.

15. The method for acoustical communication according to one of the claim 14, wherein the at least one second directionally dependent microphone (15) is implemented as a contact microphone.

16. The method for acoustical communication according to claim 14, wherein the signal captured by a first directionally dependent microphone (16) is filtered by means of the signal captured by a third microphone (13).

17. The method for acoustical communication according to one of the claims 14 to 16, wherein an amplifier (48) is controlled by means of the signal captured by a third microphone (15).

18. The method for acoustical communication according to one of the claims 14 to 17, wherein the signal captured by a directionally dependent microphone (15) is processed based on reference filters.

19. The method for acoustical communication according to one of the

claims 14 to 18, wherein the at least one directionally dependent microphone (13, 15, 16) is implemented as a microphone array.

20. The method for acoustical communication according to claim 19, wherein the at least one microphone array is implemented in MEMS technology.

21. The method for acoustical communication according to one of the claims 14 to 20, wherein the captured signals (22, 24) are transmitted to a mobile radio device (30).

22. The method for acoustical communication according to one of the claims 14 to 21, wherein the user has image data projected onto the retina using a retinal scanning display.

23. The method for acoustical communication according to claim 22, wherein the direction of view of the user is captured by means of a module.

24. The method for acoustical communication according to one of the claims 14 to 23, wherein spoken commands are captured by means of a speech recognition module.

25. The method for acoustical communication according to one of the claims 14 to 24, wherein the captured signals are transmitted to an external device via a Bluetooth and/or a ZigBee and/or a GSM and/or a UMTS interface.

26. The method for acoustical communication according to one of the claims 14 to 25, wherein the power supply (14) is provided through photovoltaic cells.

AMENDED PAGE

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/051425

A. CLASSIFICATION OF SUBJECT MATTER
H04M1/03 H04M1/05 H04M1/60 H04M1/725

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04M G02B H04R G02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC, WPI Data, PAJ, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2004/016037 A (UNIV NANYANG 'SG!; CHEN JIAN FENG 'SG!; YU ZHU LIANG 'SG!; SONG YING ') 19 February 2004 (2004-02-19) abstract page 5, lines 2-4,21-25 page 8, lines 16-27 page 10, lines 24-28 page 12, lines 5,6 figures 1,3-5	1,2,4-7, 9,13-16, 18-21, 23,27,28
X	US 5 483 599 A (ZAGORSKI ET AL) 9 January 1996 (1996-01-09) abstract column 1, lines 15-22,45-60 column 2, lines 56-67 column 5, lines 27-37,56,57 figures 3,8	1,15

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 December 2005	20/12/2005

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Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/051425

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 199 59 493 A1 (BUNZEL, WOLF; JAEHNERT, JAN) 25 May 2000 (2000-05-25) the whole document	3,17
A	GB 2 377 581 A (* NEW TRANSDUCERS LIMITED) 15 January 2003 (2003-01-15) abstract figure 2a	3,17
A	DATABASE INSPEC 'Online! THE INSTITUTION OF ELECTRICAL ENGINEERS, STEVENAGE, GB; July 2002 (2002-07), NIEW J: "Surface mount microphone creates new options for manufacturers" XP002357137 Database accession no. 7382434 abstract & European Electronics Engineer Setform Ltd UK, July 2002 (2002-07), pages 22-24,	8,22
A	US 5 903 397 A (KOLLIN JOEL S ET AL) 11 May 1999 (1999-05-11) abstract	10,24
A	EP 0 562 742 A (MOTOROLA INC) 29 September 1993 (1993-09-29) abstract figure 8	10,24
A	US 5 682 210 A (WEIRICH JOHN) 28 October 1997 (1997-10-28) abstract column 2, lines 12,13 figure 4	11,25
A	US 2002/197961 A1 (WARREN PETER) 26 December 2002 (2002-12-26) cited in the application abstract paragraphs '0005!, '0006!, '0023!, '0026!, '0028! - '0031! figures 1,2	12,26

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP2005/051425

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004016037 A	19-02-2004	AU 2002329160 A1	25-02-2004
US 5483599 A	09-01-1996	CA 2097136 A1 US 5243660 A	29-11-1993 07-09-1993
DE 19959493 A1	25-05-2000	NONE	
GB 2377581 A	15-01-2003	NONE	
US 5903397 A	11-05-1999	NONE	
EP 0562742 A	29-09-1993	JP 6138499 A	20-05-1994
US 5682210 A	28-10-1997	NONE	
US 2002197961 A1	26-12-2002	NONE	